Implementation of a Dual on Die 140 V Super-Junction Power Transistors

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Abstract

Increasing the switching frequency for switch mode power supplies is one method to achieve smaller, lighter weight and hopefully cheaper power converters.

Silicon is not only the dominant material used to produce the switches but also it allows more circuitry to be easily integrated on the same die.

This work presents an application customized switches to be used in switch mode power supplies.

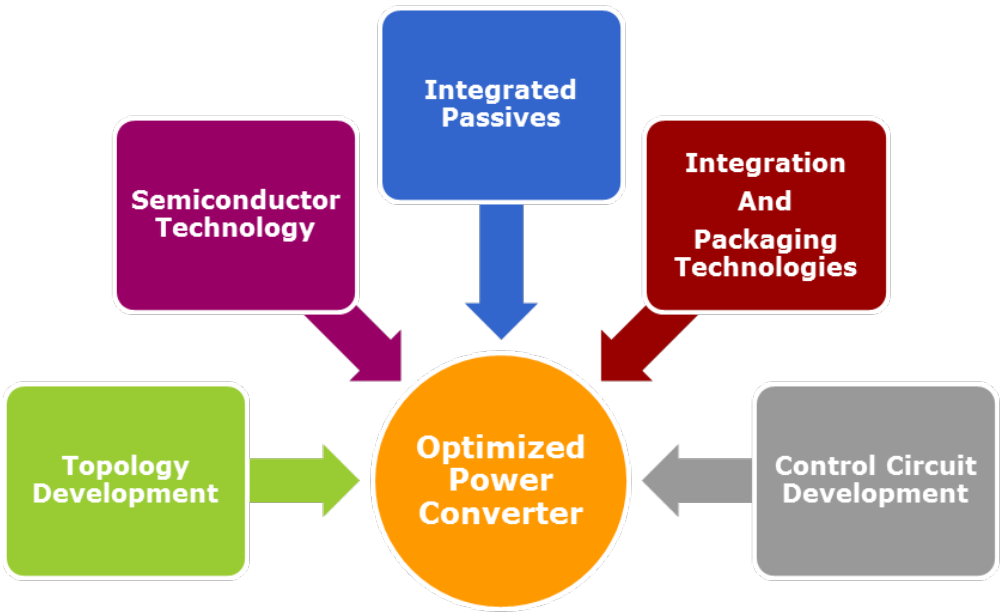
The prototype chip was implemented using a 0.18 µm SOI process and includes dual electrically isolated 140 V, 1.2 Ω N-channel MOSFETs.

Project Objectives

Wider Objective:
Develop an Integrated switch-mode power supplies utilize few external components.

Specific Objectives:
To integrate the DTU Elektro proven dc-dc converter topologies in a single module / chip.
To develop state of the art, high power density, high quality power supply prototypes.

Converter



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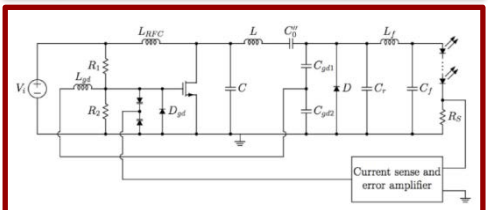
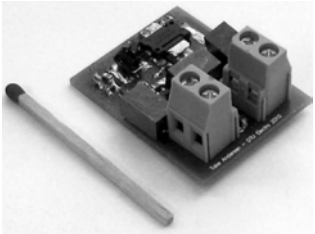
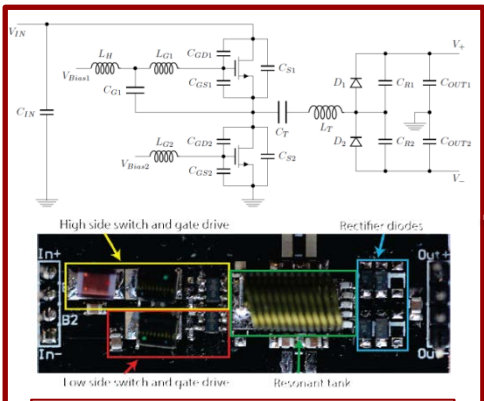
Single Cell Converters developed at DTU

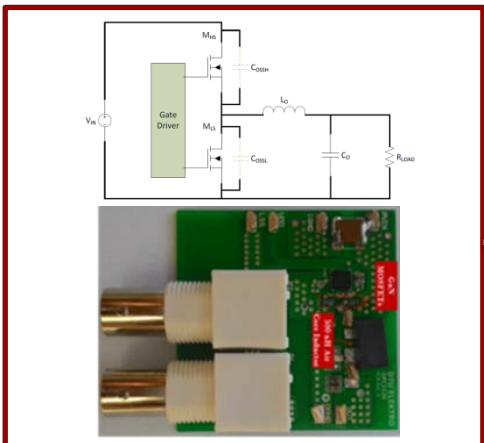




Class E Resonant Converter *

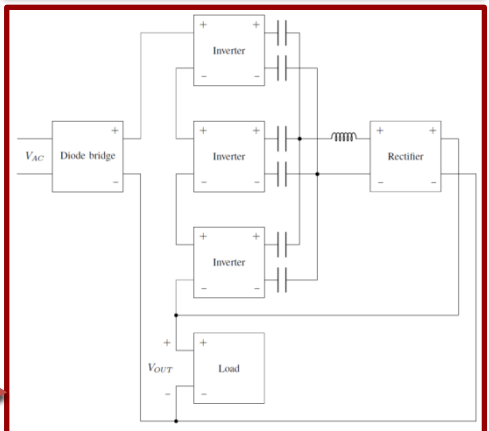


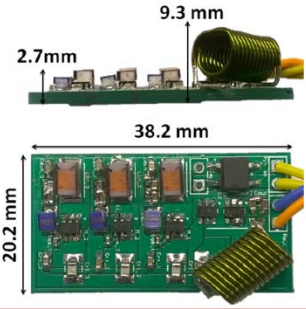
Class DE Resonant Converter **



Buck Converter ***

Stacked Cells Converter Developed at DTU





US Mains Converter****

* **Andersen, T.M. , Christensen, S.K. , Knott, A. , Andersen, M.A.E. , "**A VHF class E DC-DC converter with self-oscillating gate driver.", Applied Power Electronics Conference and Exposition (APEC), pages 885–891, March 2011

** **Madsen, M.P.; Knott, A.; Andersen, M.A.E.,** "Very high frequency half bridge DC/DC converter", Applied Power Electronics Conference and Exposition (APEC), 2014 Twenty-Ninth Annual IEEE , vol., no., pp.1409-1414, 16-20 March 2014

*** **Yasser Nour, Arnold Knott, Ivan H. H. Jørgensen,** ; "Investigating Enhancement Mode Gallium Nitride Power FETs in High Voltage, High Frequency Soft Switching Converters," *IEEE International Conference on Power electronics, machines and drives (PEMD 2016)*, Glasgow, 2016.

**** **J. A. Pedersen, M. P. Madsen, J. D. Mønster, T. Andersen, A. Knott and M. A. E. Andersen,** "US mains stacked Very High Frequency self-oscillating resonant power converter with unified rectifier," 2016 IEEE Applied Power Electronics Conference and Exposition (APEC), Long Beach, CA, 2016, pp. 1842-1846

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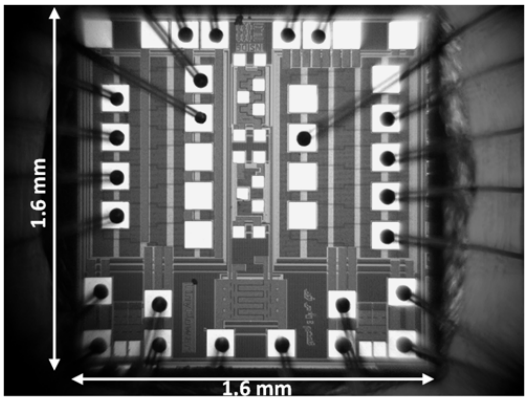
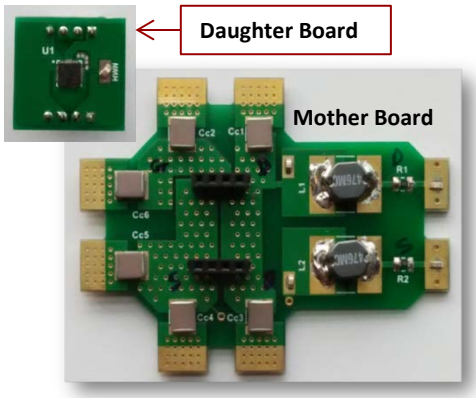
Semiconductor Technology

First Generation Switches

- Dual on Die" Electrically 140 V Isolated Super-Junction N-Channel Transistors.
- Using a 0.18 µm SOI process.
- Ron = 1.2 Ω for each switch. (@ 0.1 Vds)
- Designed for homogenous current distribution across the die.
- Die Size is 1.6 mm x 1.6 mm

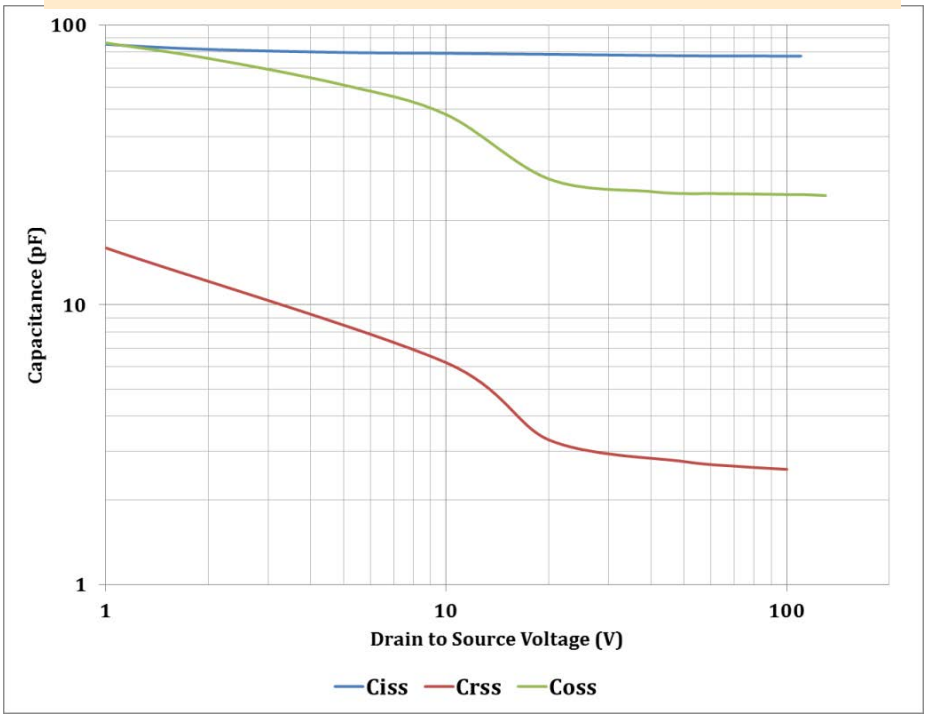


Photomicrograph of the designed chip



Characterization PCBs

Measured using Agilent 4294A precision impendence analyzer @ 1MHz



Characterization Results